



Short communication

Snaring in a stronghold: Poaching and bycatch of critically endangered tigers in northern Sumatra, Indonesia

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ABSTRACT

Wire-snare poaching is increasingly recognized as a major threat to endangered large carnivores in Africa and Asia. However, empirical information on the extent and distribution of snaring remains extremely limited beyond anecdotal reports presenting opportunistically collected data. In this study, we compile information to present a comprehensive synopsis of snaring of critically endangered Sumatran tigers (*Panthera tigris sumatrae*). Hunted for their parts and skins, Sumatran tigers remain in high demand in illicit international markets. We focus our analysis on the provinces of Aceh and North Sumatra, Indonesia, which cumulatively contain ~36 % of the island's remaining tiger habitat. Based on records collected from a combination of Indonesian government data, ranger patrol observations, and content analysis of local media, we identified 13 tiger snaring hotspots and documented 28 verified incidents of ensnared tigers between March 2008–March 2023. These totals represent minimum estimates because of spatiotemporal gaps in ranger patrols and inconsistent reporting of snaring by local communities. Our analysis of the incidents reveals tiger mortality in 9 (32.1 %) of the cases and permanent moves to ex-situ settings due to amputation or other debilitating snaring-induced injuries in another 8 (28.6 %) cases. Tiger snaring was positively correlated with forest-edge habitats in the Leuser Ecosystem, where 64.3 % of all incidents occurred. Across both provinces, 28.6 % of all snared tigers were allegedly captured in snares set in agricultural areas to control wild boar. To maximize efficacy of the government's ongoing anti-snare campaigns, we recommend increased personnel for ranger patrols and more attention on tiger-specific snaring impacts.

1. Introduction

Poaching of large carnivores is widespread (Becker et al., 2013; Chapron and Treves, 2016; Mudumba et al., 2021). Consequently, and in combination with deforestation, 60 % of these species have lost more than half of their historic ranges (Wolf and Ripple, 2017). As a result of these declines, important ecological effects have been considerably reduced or lost (Bello et al., 2015). These include direct effects through predation and indirect effects on prey behavior and ecosystem function, including energy flow and nutrient cycling (Morris and Letnic, 2017).

Among large carnivores worldwide, Sumatran tigers (*Panthera tigris sumatrae*) are one of the most critically endangered species with the most recent data indicating an island-wide estimate of less than 600 individuals (Goodrich et al., 2022). One of the main proximate threats to Sumatran tigers is poaching to supply demand in international markets (Shepherd and Magnus, 2004; Risdianto et al., 2016). Between January

2000 and June 2022, Indonesia recorded 207 seizures (9 % of all seizures globally) of tigers and their parts, representing the third highest total among all countries over this period (Wong and Krishnasamy, 2022).

Once widely distributed throughout the island, many Sumatran tiger populations are now restricted to suboptimal habitat in fragmented patches abutting human settlement and agriculture (Wibisono et al., 2009; Widodo et al., 2022). Besides poaching, the species is threatened by habitat loss, prey depletion, disease (e.g., canine distemper virus), and conflict with humans (Linkie et al., 2015; Luskin et al., 2017; Lubis et al., 2020; Mulia et al., 2021; Figel et al., 2023).

Northern Sumatra is a stronghold for Sumatran tigers (Wibisono et al., 2011). Within the borders of its two provinces – Aceh and North Sumatra – lies ~36 % of the species' island-wide habitat (Goodrich et al., 2022). This includes the 26,500 km² Leuser Ecosystem (hereafter, Leuser), one of the largest tiger conservation landscapes in Southeast

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Asia (Wibisono et al., 2011; Baabud et al., 2022). Spanning 8303 km², Gunung Leuser National Park is the core area of this ecosystem. The next largest tiger-inhabited protected areas of northern Sumatra are Batang Gadis National Park (1080 km²), Rawa Singkil Wildlife Reserve (1025 km²), Lingga Isaq Game Reserve (800 km²), and Barumum Wildlife Reserve (403 km²) (UNEP-WCMC and IUCN, 2023). These protected areas are the focus of government de-snaring operations and NGO-supported SMART patrols, in operation since 2014 (Lubis et al., 2020). Besides snare removal, the patrol teams respond to human-tiger conflict incidents, monitor tigers via camera-traps and track surveys, and serve as liaisons between governmental natural resource agencies and local communities. The identification and maintenance of healthy tiger populations are reliant on these consistent monitoring efforts (Karanth and Nichols, 2002; Duangchantrasiri et al., 2016).

In Sumatra, where strict laws make gun ownership uncommon, snaring is the most common form of tiger killings (Linkie et al., 2015; Risdianto et al., 2016). Snares are cost-efficient and relatively simple to conceal, transport, and install. Despite increasing awareness of the threat of snares, research on the factors influencing their occurrence in Sumatra is limited. Consequently, relationships between anthropogenic pressures (e.g., deforestation) and snaring are poorly understood. From other sites in tropical Asia, some studies suggest that snaring of large felids is correlated with human population densities (Gubbi et al., 2021). Other research, however, demonstrates greatest snare abundance at closer proximities to markets of demand (e.g., along the Vietnam border) (O'Kelly et al., 2018). Varying determinants of snare prevalence highlight the need for further attention on site-specific determinants of the presence of these traps.

There are several categories of people, with varying intent, involved in the snaring of tigers in northern Sumatra. The first two groups – farmers attempting to control wild boar (*Sus scrofa*) in agricultural areas and deer hunters – usually capture tigers incidentally due to bycatch. The third group – poachers – pursues tigers for profit. The target species of each of these groups can be determined by several characteristics of the snare such as its material, diameter of the noose, habitat type, and design and positioning at the trap site.

Whereas hunters use wire and nylon rope to ensnare deer primarily in forests and farmers use the same materials for wild boar primarily in agricultural areas, heavy-duty wire and metal cables with diameters of 5–8 mm (i.e., tiger snares) are used by tiger poachers. Snares set for tigers require greater resistance from the captured animal's struggle as it attempts to free itself. Thus, saplings with a diameter at breast height of 8–12 cm are selected to spring traps set for tigers in protected forests whereas smaller saplings can be used for wild boar in agricultural areas (Figel et al., 2021).

The main snare type used by tiger poachers in northern Sumatra are foot snares, which are set on animal trails in the forest, usually along ridgelines (Figel et al., 2021). The poacher digs a small hole, covers it with a line of several small sticks, and then sets the snare encircling the hole's edge. One end of the snare is tied to a bent sapling, positioned 2–4 m from the trail, at a 90-degree angle from the snare. When a tiger steps in the snare and through the hole, the sapling violently springs, which then triggers the noose to instantaneously tighten around the animal's limb. The poachers are often supplied with snaring materials by traders and buyers (Tilson et al., 2010).

Farmers in northern Sumatra commonly attempt to protect crops from wild boar and other crop-raiding animals by setting snares in their farms and gardens (Linkie et al., 2007). Due to their Islamic faith, most of these farmers do not consume boar meat. In addition to foot snares, which are designed to capture boar and other target animals by the foot or ankle, neck snares are also frequently used for boar in agricultural areas. Farmers set neck snares along a line with up to several dozen wire or nylon nooses suspended vertically from a rope that is fastened on both ends to trees usually separated by distances of 10–15 m. The more the captured boar struggles, the tighter the loop becomes around the animal's neck, ultimately causing suffocation.

Wild boar, a main prey item of tigers (Karanth and Stith, 1999), can proliferate in fragmented forest-edge habitats, particularly in oil palm landscapes that provide extensive supplementary food sources (Ickes, 2001). Both foot and neck snares set in agricultural areas for wild boar (hereafter boar snares) inadvertently capture non-target animals such as Sumatran tigers and sun bears (*Helarctos malayanus*) (Figel et al., 2021). Akin to discarded fishing tackle catching protected species in marine ecosystems (Wilson et al., 2014), untriggered boar snares may capture tigers and their prey long after they were set.

Finally, deer hunters use snares (hereafter deer snares) for consumption. The main species targeted are sambar (*Rusa unicolor*) and Southern red muntjac (*Muntiacus muntjak*). Deer snaring, which regularly takes place inside protected forests and, less frequently, in agricultural areas (J.J. Figel, pers. observ.), often intensifies in the months preceding the Islamic holy month of Ramadan when demand for venison increases before celebratory events associated with the Idul Fitri holiday (Risdianto et al., 2016). Deer, especially sambar, are a main tiger prey item and the two often exhibit considerable spatio-temporal overlap in Southeast Asian rainforests (Steinmetz et al., 2013). This co-occurrence increases tiger susceptibility to capture in deer snares.

As wide-ranging apex predators, Sumatran tigers are disproportionately impacted by snaring because the traps catch both the predators and their prey and prey depletion is a major contributor to tiger decline (Karanth and Stith, 1999). Yet, estimates of Sumatran tiger mortalities and injuries from snares in northern Sumatra have not yet been presented. In this study, we quantify minimum numbers of tigers killed and injured over a 15-year period from March 2008–March 2023. We also report: 1) characteristics (e.g., elevation, dominant habitat) of tiger snaring sites, 2) distribution of snaring in northern Sumatra and 3) spatial and temporal variation in snaring. This information is intended to identify tiger snaring hotspots and guide more targeted anti-snare programs.

2. Methods

2.1. Study area

In Aceh and North Sumatra, the tiger's range spans approximately 35,128 km² and 15,553 km², corresponding to 63.4 % and 23.6 % of each province's mainland. The provinces' expansive forests are a priority I tiger conservation landscape (Wibisono et al., 2011). The backbone of Sumatran tiger distribution is the Barisan Mountain range which, in northern Sumatra, contains six peaks surpassing 2800 m a.s.l., including the second-highest peak on the island – Mount Leuser at 3466 m.

The human population densities in Aceh and North Sumatra are approximately 91 people/km² and 210 people/km² (Badan Pusat Statistik (BPS), 2023a; Badan Pusat Statistik (BPS), 2023b). With populations of ~253,000 and ~189,000 inhabitants, Banda Aceh and Lhokseumawe are the two largest cities in Aceh while Medan (~4.7 million inhabitants) and Pematangsiantar (~268,000 inhabitants) are the two largest cities in North Sumatra (Badan Pusat Statistik (BPS), 2023a; Badan Pusat Statistik (BPS), 2023b). Villagers in rural communities grow rice and other cash crops such as bananas, maize, durian, chilis, candlenut, and betel nut. Oil palm plantations are the main form of industrial agriculture (AURIGA, 2019).

The tiger's primary prey base in Aceh includes four ungulates, all subject to snaring pressures, albeit at varying levels: sambar, wild boar, Southern red muntjac, and Sumatran serow (*Capricornis sumatraensis*) (Figel et al., 2021).

2.2. Data collection

Our analysis is based on a human-tiger conflict dataset, collected and maintained by the local government's Natural Resources Conservation Agency, known in Aceh as BKSDA-Aceh and BBKSDA Sumatera Utara in

North Sumatra. As government agencies, BKSDA-Aceh and BKSDA Sumatera Utara are responsible for managing wildlife-related issues at the provincial and district levels. Snaring incidents were reported to each agency via an extensive network of local informants, including village leaders and staff of local environmental NGOs. Each snaring case included the following details: date of the incident, location (including GPS coordinates), and number of tigers involved. In some cases, sex and age class of the tiger were also included. Besides snaring incidents, the human-tiger conflict dataset includes information primarily on livestock depredation by tigers and incidents of “roaming” tigers reported at uncomfortably close proximities to human settlement (Figel et al., 2023).

Data acquisition for the human-tiger conflict database was influenced by several notable spatial and temporal gaps in tiger conservation activities and on-the-ground enforcement for wildlife protection. Primarily attributable to funding inconsistencies, these gaps largely mirrored the commencement or discontinuation of several multi-year, landscape-scale monitoring programs. For example, in 2011 the government of Aceh partnered with Fauna and Flora International to implement an innovative community ranger program in Aceh’s Ulu Masen Ecosystem, a 7380 km² forest block adjacent to Leuser. For three years, rangers from 28 forest-edge communities conducted patrols to remove snares, monitor endangered wildlife, and report wildlife crime. The program was a working example of effective community-based forest protection until funding ended in 2014 (FFI, 2014). In 2015, the Wildlife Conservation Society initiated the 5-year USAID LESTARI project, which mobilized 10 snare-removing ranger teams in the western part of Leuser (USAID LESTARI, 2020). Also in 2015, the German government and the International Union for Conservation of Nature (IUCN) collaborated with the Indonesian government and local partners to implement a multi-year, multi-million-dollar investment in Sumatran tiger conservation via the Integrated Tiger Habitat Conservation Programme. In northern Sumatra, project activities of that initiative (which also includes ranger patrols) have focused almost exclusively on Leuser (ITHCP Integrated Tiger Habitat Conservation Programme, 2021). At present, Ulu Masen has minimal ranger presence compared to Leuser despite widespread tiger occurrence in both ecosystems (Wibisono et al., 2011).

We supplemented the government data by conducting a media content analysis of tiger snaring incidents in online news portals for a 15-year period from March 2008–March 2023. The Indonesian news portals included Aceh TribunNews (<https://aceh.tribunnews.com/>), Kompas (<https://www.kompas.com/>), Antara (<https://en.antaranews.com/>), Mongabay-Indonesia (<https://www.mongabay.co.id/>), and Tempo (<https://www.tempo.co/>). We conducted the search in both English (keyword search: Tiger, Sumatra, snare, Aceh, North Sumatra) and Indonesian (keyword search: Harimau, Sumatera, jerat, Aceh, Sumatera Utara). In Sumatra, tiger incidents attract considerable attention from the media (e.g., Butarbutar, 2017; Serambinews, 2021), which generally publishes a brief narrative of the incident. Thus, media analysis can be an effective tool for collecting data on a sensitive topic that is difficult to obtain via other sources such as interviews (Krippendorff, 2004).

To corroborate details found in the media or human-tiger conflict database, we searched the Electronic Thesis and Dissertation repositories of the three main universities in northern Sumatra: Universitas Syiah Kuala and Universitas Islam Negeri Ar-Raniry in Banda Aceh and Universitas Sumatera Utara in Medan. For this search, we used the same key words as the media content analysis.

2.3. Data analysis

We recorded the location and date of the snaring incidents, type of snare used, number of tigers snared, and a brief description of the response by government natural resource agencies. Before mapping, we separated the tiger snaring incidents into four categories: 1) mortalities, 2) major injuries followed by permanent move to captivity, 3) escapes

(e.g., a captured tiger freeing itself), and 4) minor injuries that required minimal treatment before release back into the forest. The escapes were determined by video documentation (either from camera-traps or cell-phone recordings by villagers or government officials) of tigers missing parts of limbs or exhibiting severe snare-induced injuries.

We identified tiger snaring hotspots which, considering the critically endangered status of Sumatran tigers and their susceptibility to snaring, we define as sites with either cluster traps or at least two tiger snaring incidents recorded between March 2008–March 2023. Cluster traps in Sumatran rainforests are a tell-tale sign of tiger poachers. These formations increase probability of captures as they include multiple snares (up to 30 in extreme cases) set within a few square meters along forest trails, particularly at ridgelines and other favored pathways of tigers (Risdiyanto et al., 2016; Figel et al., 2021).

We used Nusantara Atlas, an open-access interactive platform (Nusantara Atlas, 2023), to plot the snaring records in relation to four main land cover types: agricultural areas, provincially managed “production” forests (*hutan produksi*) and protected forest (*hutan lindung*), and federally managed conservation areas. Commercial logging is allowed in production forests but prohibited in protected forest or conservation areas. We used the ggplot 2 package in R version 4.1.2 for data visualization (Wickham, 2016; R Core Team, 2020).

3. Results

Throughout northern Sumatra, we recorded 28 cases of snared tigers over a 15-year period from March 2008–March 2023 (Fig. 1). The two main data sources revealed considerable overlap in results, with the media covering 20 of the 28 cases. Six cases, not included in the HTC dataset or media, were uncovered from observations by Leuser International Foundation ranger teams. Across both provinces, the average number of ensnared tigers was 1.2 individuals ± 0.55 SD per incident. There were two cases, both in Aceh, when a female tiger and her two cubs were fatally snared. Among the incidents where sex was identified ($n = 20$ of 28 cases; 71.4 %), female tigers were most often snared ($n = 14$ of 20 cases; 70 %).

Snaring of tigers occurred in 20 distinct districts in northern Sumatra. Four districts experienced repeated incidents of tiger snaring. Tiger snaring resulted in mortalities ($n = 9$), major injuries requiring a permanent move to captivity ($n = 9$) (Fig. 2), escape from the trap ($n = 6$) (Supplementary Fig. S1), and minor injuries requiring minimal treatment before release back into the forest ($n = 4$) (Fig. 3). Based on characteristics of snares and the habitats in which they were placed, a minimum of 10 cases (35.7 %) involved deliberate tiger-targeted snaring by poachers. Notably, 28.6 % of all snared tigers were allegedly captured in snares set in agricultural areas for wild boar. One severely wounded tiger – later requiring amputation – was reportedly caught in a deer snare. Details could not be obtained for the snares from which the six tigers escaped. The remaining three cases lacked sufficient detail to accurately determine the target species.

We identified 13 tiger snaring hotspots, 11 (84.6 %) of which were at forest-edge habitats (Fig. 1; Supplementary Fig. S2). Tigers were snared at an average elevation of 429 m a.s.l. ± 413.9 SD. Across all years, we documented considerable monthly fluctuations in tiger snaring, with 41.7 % of all cases occurring in the months of March and April.

By land cover type, 67.9 % ($n = 19$) of all tiger snaring incidents occurred in agricultural areas. The remaining snaring cases occurred in production forests (*hutan produksi*) ($n = 5$, 17.9 %) and protected forest (*hutan lindung*) ($n = 4$, 14.3 %).

4. Discussion

Our study is the first to assess tiger-specific snaring impacts anywhere within the species’ 10 remaining range countries. We demonstrate high rates of tiger mortality and debilitating injuries caused by snares and provide crucial information about the distribution of tiger

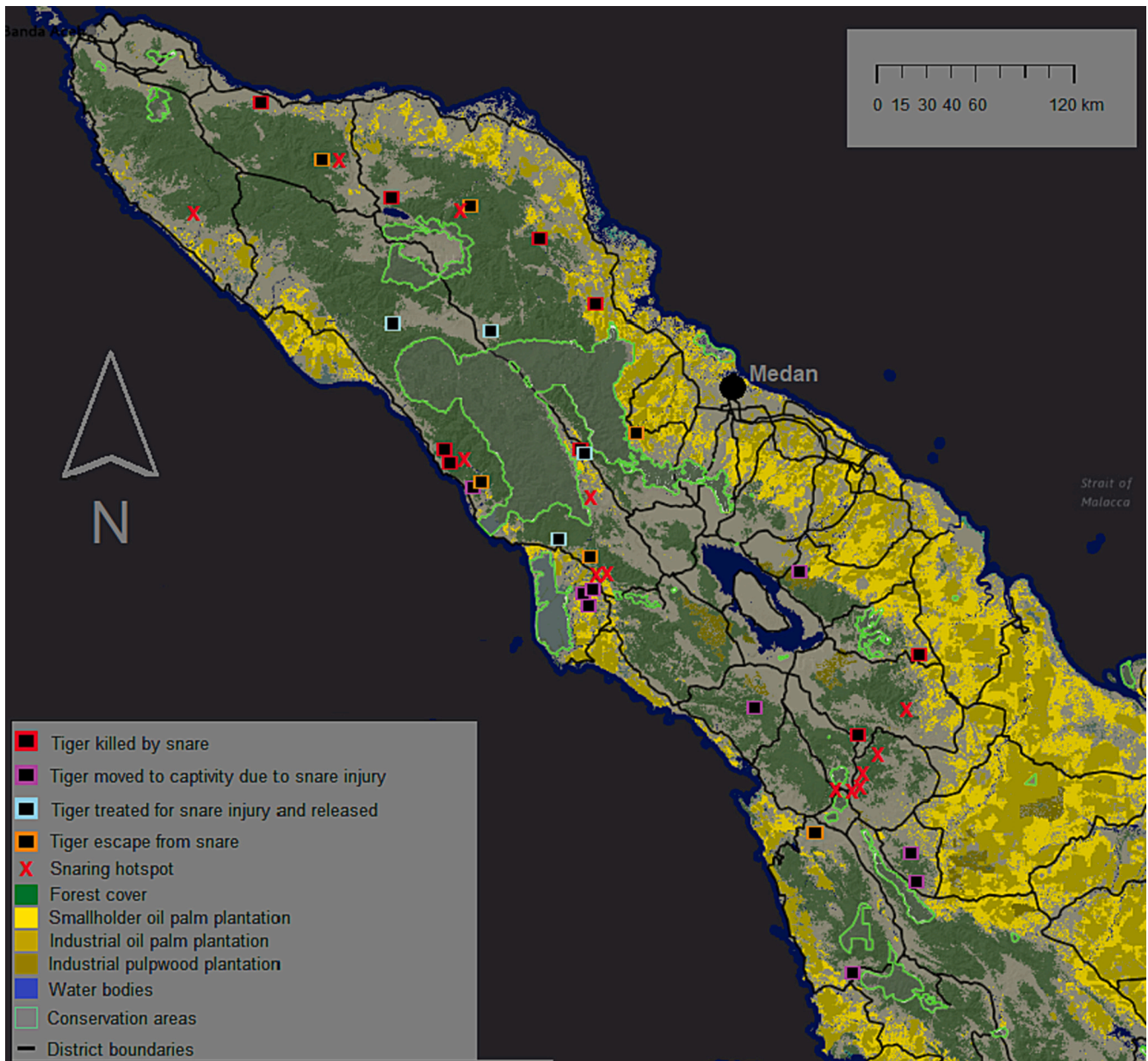


Fig. 1. Distribution of tiger snaring incidents in northern Sumatra between March 2008 and March 2023. As the most populous city in northern Sumatra, Medan remains a major hub for illegally traded tiger parts.

snaring hotspots. Considering that snares were the main cause of recent tiger extirpations in rainforests of mainland Southeast Asia (Rasphone et al., 2019), these traps represent an existential threat to critically endangered Sumatran tigers (Dinas Lingkungan Hidup dan Kehutanan (DLHK, Aceh), 2019).

We emphasize that our data should be considered a minimum estimate as we could not account for the unknown number of tigers that either died or escaped from snares. The mountainous rainforests of northern Sumatra pose formidable challenges for locating these cryptically placed traps and estimating their true extent. In Cambodia, snare detection probabilities in a controlled study were only ~ 0.33 , which indicates that the magnitude of this problem is considerably greater than observed (O’Kelly et al., 2018). Greater dissemination of results from snare patrols and improved coordination among local organizations addressing this issue would help reveal the true extent of tiger snaring in northern Sumatra.

After $\sim 20,000$ km of patrol effort in 2018 by anti-poaching teams

affiliated with the Forum Konservasi Leuser, 843 snares in Aceh were documented and dismantled at a rate of 4.2 snares removed/100 km² (Figel et al., 2021). Further south, in West Sumatra’s 13,800 km² Kerinci-Seblat National Park, rangers removed 4433 snares from 2000 to 2010 at a rate of 49.9 snares/100 km² (Linkie et al., 2015). Despite the greater prevalence of snares in Kerinci-Seblat, snare types varied significantly between the two sites; 122 tiger snares were removed from Kerinci-Seblat over the 10-year period whereas 233 tiger snares were removed from Aceh in 2018 alone (Linkie et al., 2015; Figel et al., 2021). With only 30 km separating its southeastern border with Medan – one of the major markets of demand for tiger parts in Southeast Asia (Shepherd and Magnus, 2004) – edge habitats along Gunung Leuser National Park are especially vulnerable to poaching incursions.

In accordance with Indonesia’s Law No. 5 (1990) on the Conservation of Biological Resources and Ecosystems, the maximum fine and sentence for killing (or illegally transporting) protected species such as tigers is five years and/or IDR 100 million (approximately USD \$6556).



Fig. 2. Juvenile tiger with an amputated limb after government rescue from a snare in Subulussalam, a tiger snaring hotspot in Aceh (photo Leuser International Foundation).

In October 2019, the government of Aceh committed greater attention to the issue when it enacted new legislation, in Article 32 of its regional regulations known as Qanun, that explicitly prohibits the construction and use of snares capable of harming wildlife (Dinas Lingkungan Hidup dan Kehutanan (DLHK, Aceh), 2019). The deterrence effect of these laws, however, may not reach its full potential considering the discrepancy between the amount of the fine and profit on the black market. In northern Sumatra, tiger skins and bones are normally sold for USD \$6500–\$8000 (Dinas Lingkungan Hidup dan Kehutanan (DLHK, Aceh), 2021).

Our findings demonstrate a need for increased ranger presence in forest-edge communities, particularly in the months of March and April when deer hunters appear to be most active. Indeed, the disproportionate number of tiger snaring incidents we documented in these two months coincides with the season when demand for deer meat increases to celebrate events associated with Idul Fitri, a main Islamic holiday following the month of Ramadan. Ramadan-related increases in deer hunting were also documented in tiger habitats of west Sumatra (Risdiyanto et al., 2016). Despite the long history of deer meat in celebratory events of rural northern Sumatra and cultural sensitivities associated

with halting this practice, the reality is that both sambar and Sumatran serow are threatened species and therefore protected by the Indonesian government (P.106/MENLHK/SETJEN/KUM.1/12/2018).

The higher incidence of female tigers caught in snares in northern Sumatra may be attributable to their periodic travel with cubs. Compared to solitary individuals, groups of animals can be more susceptible to snare entrapment (Becker et al., 2013). Also, in their attempt to feed cubs in prey-scarce rainforests, female tigers may become reliant on livestock and wild boar in areas of intensive snaring along forest edges bordering human settlement. As there is a strong positive effect of prey abundance on tiger occurrence and ranging behavior (Karanth et al., 2004), elevated wild boar densities in agricultural areas may be a key factor in drawing tigers to the forest edge. Some variation of this phenomena appears to also be occurring in southwest India where snares set for boar in crop fields were responsible for 21 of the 67 snared leopard (*Panthera pardus fusca*) fatalities recorded from 2009 to 2020 in Karnataka state (Gubbi et al., 2021).

To reduce tiger entrapment in agricultural areas, there is a need to support farmer management of wild boar using methods besides snares, as there are other efficient alternatives that can reduce bycatch

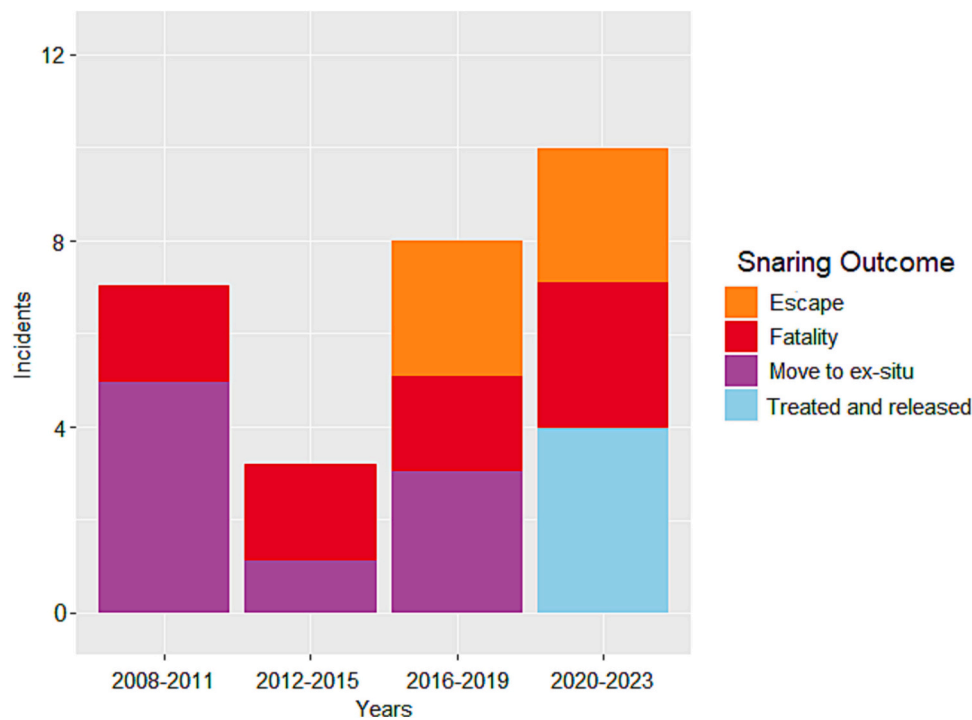


Fig. 3. Temporal composition of tiger snaring incidents in northern Sumatra, March 2008 – March 2023.

(Gaskamp et al., 2021). For example, the Gayo and Minangkabau indigenous groups of Aceh and North Sumatra traditionally use hunting dogs to scare and control boar populations in agricultural areas. These large hunting groups, comprised of up to several dozen men and dogs, operate on a weekly basis. Guard dogs can effectively reduce damage caused by crop-raiding pests, including wild boar (Kyokuhare et al., 2022). Although dog hunting can also cause high levels of bycatch (Luskin et al., 2014), there are cases – particularly when dogs are trained to specifically pursue wild boar (*anjing babi*) in agricultural areas only – when this method could potentially have less impact on tigers and their prey, compared to snaring. It is important to note, however, the tremendous need for greater awareness of canine distemper virus (CDV) as an emerging threat to Sumatran tigers (Mulia et al., 2021). CDV vaccination of trained hunting dogs is necessary to help prevent the emergence and spread of this highly contagious disease in Sumatra.

The maimed, crippled tigers that escape from snares and subsequently documented on camera-trap are cause for concern because severely wounded tigers are likely to occupy smaller home ranges, experience malnourishment, and frequent degraded habitats due to difficulties defending territories from healthy animals (Sunquist, 1981). Physical ailments in large carnivores can alter their behavior (Becker et al., 2013) and increase risk of human-tiger conflict, which is widespread in lowland habitats of northern Sumatra (Figel et al., 2023). We recommend greater training opportunities for veterinarians to facilitate successful tiger rescues from snares. Prompt veterinary attention can significantly improve the likelihood of recovery from snare entrapment for both tigers and sympatric mammals also threatened by snares while also providing opportunities to vaccinate tigers for CDV (Hagglade et al., 2019; Figel et al., 2021; Gilbert et al., 2023).

The greater proportion of ensnared tigers treated and released between 2020 and 2023 is partially attributable to the operations of the “Wildlife Ambulance” program, based in Banda Aceh since 2017. Operating out of Universitas Syiah Kuala, home to Sumatra’s only veterinary curriculum, the Wildlife Ambulance provides emergency veterinary treatment to sick and injured wildlife, including ensnared tigers.

To curb tiger snaring in northern Sumatra, efforts are needed to strengthen community collaboration with law enforcement. Community alliances and local informants are especially important when snares are

set by individuals from distant localities, such as poachers coming from outside Aceh and North Sumatra. Engaging rural communities and including local reporting to guide the location and timing of patrols can significantly increase the efficiency of snare removal efforts (Linkie et al., 2015). Furthermore, employment opportunities as rangers or local informants can boost morale and provide alternative sources of income for carefully-selected people who may otherwise be likely to participate in poaching or wildlife trade. Local anti-poaching teams can also serve as direct links between local communities and government enforcement personnel (Steinmetz et al., 2014). The extent to which these collaborations are implemented and maintained is likely to determine the persistence of Sumatran tigers in northern Sumatra.

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.biocon.2023.110274>.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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